



Growth, flowering and presentability of potted azaleas as influenced by pot size and cultivars

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ABSTRACT

The present investigation was carried out at the experimental farm of the Department of Floriculture and Landscape Architecture, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during (2013-14) to find out most suitable cultivar and pot size for producing best quality and most presentable potted azaleas. The experiment was laid out in a Factorial Completely Randomized Block Design having 45 treatment combinations, viz. fifteen cultivars (John Herrens, Winter Hawk, White Rosebud, Boy-O-Boy, Summer Time, Pink Tama, Red Tomahawk, Shanghai Baby, Super Red, Nightingale, Empress, White Bouquet, Lady Love, Anniversary Joy and Royalty) and three pot sizes (25, 20 cm and 15 cm diameter) respectively. Results revealed that among the various cultivars used 'White Bouquet' recorded maximum values in terms of most of desirable characters viz., number of shoots per plant (22.77), plant spread (45.18 cm), number of flowers per plant (27.39), number of flowers per plant open at a time (19.34) and pot presentability score (84.33) whereas among the pot sizes, 25 cm diameter pots exhibited maximum plant height (32.95 cm), maximum shoots per plant (17.35), plant spread (32.06 cm), number of flowers per plant (18.04), flower diameter (7.31 cm), number of flowers opened at a time (13.50) and pot presentability score (74.71). The interaction effects of cultivars and pot sizes indicated that cv. 'White Bouquet' gave better performance w.r.t. various growth, flowering and presentability attributes of potted azaleas especially when grown in 25 cm diameter pots.

Key words: Azaleas, Flowering, Ornamental, Pot size, Presentability

Azaleas are one of the most spectacular flowering shrubs of immense utility in the hills and some of them are found growing wild in the Himalayan region. Basically, azalea is a slow growing flowering shrub of erect and multi branching nature with compact growth habit. Botanically, azalea belongs to the genus *Rhododendron* containing over 43 species (Leiser 1975). There are six azalea sub series, but the most important containing azaleas for forcing and commercial cultivation is *Rhododendron obtusum*. Though, primarily nine species have been used for the development of present day azalea cultivars, but the major role has been played by *R. obtusum* and *R. simsii*. The generic name *Rhododendron* is derived from two Greek words 'rhodon' means rose and 'dendron' meaning tree (Reiley 2004). Azalea has been a very popular ornamental plant since the Victorian times for its attractive foliage and profuse flower clusters of varied colour ranging from white, pink, orange, red, blue and purple (Reiley 2004). In some

Himalayan regions, particularly Sikkim and high altitudes of Himachal Pradesh, Uttarakhand and Jammu & Kashmir, many magnificent azaleas are found growing wild and flower in abundance. The hill stations like Coonor and Ootacamud in Tamil Nadu, Nainital in Uttarakhand, Shimla, Chail and Manali in Himachal Pradesh produce some excellent azaleas which flower during summer season. Azaleas are known as lime-hater plants and cannot grow well under alkaline conditions. They warrant for moist soil containing plenty of humus and are benefited by dry leaves of species like oak and pine needles which exhibit acidic reaction. Azaleas grow best and flower more profusely in the growing substrate having pH 4.5 to 6.0. Most of the nutrients needed by these plants for better growth, development and flower production are available in this pH range (Reiley 2004). There are a large number of cultivars in azaleas exhibiting varied growth and flowering characteristics (Criley 1985). Hence, the available azalea germplasm in the country needs to be screened for pot plant production, besides for other purposes. Container size plays an important role in manipulating the growth, development and flowering, besides the presentability of the potted plants in general and azaleas in particular. Container size alters the rooting volume, which can greatly affect the growth and ultimately flowering. As the container size increases, the plant height, leaf area, shoot biomass and root biomass also increases linearly (Cantliffe, 1993). The

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present study was conducted to select suitable cultivar(s) and pot size(s) for the growth, flowering and presentability of potted azaleas.

MATERIALS AND METHODS

The experiment was conducted in the experimental farm of Department of Floriculture and Landscaping Architecture, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2013-14. The experiment was laid out in completely randomized design (factorial) having 45 treatment combinations of fifteen cultivars and three pot sizes replicated thrice. The healthy, disease free and uniform sized two year old rooted plants of fifteen cultivars of azalea namely, John Herrens, Winter Hawk, White Rosebud, Boy-O-Boy, Summer Time, Pink Tama, Red Tomahawk, Shanghai Baby, Super Red, Nightingale, Empress, White Bouquet, Lady Love, Anniversary Joy and Royalty were planted in the plastic pots of 25 cm (S_1), 20 cm (S_2) and 15 cm (S_3) diameter containing a sterilized potting mixture comprising of soil, sand, well rotten farmyard manure and leaf mould of *Rhododendron arboretum* L. (1:1:1:1 v/v) in the shade net house. Immediately after planting, the light irrigation was given to the plants for better establishment. For ensuring better growth, development and flowering of azalea plants, fertigation with 19:19:19 (NPK) @ 1 g/l once a week was practiced. To keep the potting mixture moist and protecting the roots from heat and cold injuries, mulching with sphagnum peat moss was done. Depending upon the prevailing weather conditions, pots were irrigated manually with the help of watering can twice a week from the time of planting till the termination of experiment. The other intercultural operations like hoeing, weeding, removal of dried, dead and diseased leaves and shoots *etc.* were also accomplished depending upon the requirement. Pruning was done to encourage vegetative growth and production of more lateral shoots. All the plants were inspected for the infestation of various insect-pests and diseases at regular intervals. Attacks of greenhouse white flies (*Trialeurodes vaporariorum*) were recorded in azaleas and for controlling them, yellow traps were used. In addition, fortnightly spraying of plants with cypermethrin @ 1ml/l and Decis @ 1ml/l was practiced, alternatively. To maintain the health and keeping the plants free of various diseases, fortnightly drenching and spraying with Dithane M-45 @ 2 g/l and Bavistin @ 1 g/l was done, alternatively. All growth and flowering parameters like plant height, plant spread, number of shoots/plant, flower diameter and maximum number of flowers/plant open at a time were recorded at the time of peak flowering. Time taken in days from pruning to the opening of first flower was recorded as the number of days taken for flowering. Pots were evaluated for their presentability on the basis of point system modified after Conover (1986). The data were recorded on various growth, flowering and pot presentability attributes for two consecutive years and analysed using analysis of variances as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Plant height (cm)

A perusal of pooled data in Table 1 revealed that cultivars as well as pot sizes exhibited significant effects on plant height. Maximum plant height (46.95 cm) was observed in cv. Royalty and minimum (23.19 cm) in cv. Winter Hawk. The production of taller plants in cv. 'Royalty' could be attributed to the more genetic vigour of this cultivar in comparison to others. The variation in plant height of various cultivars tested may be due to the effect of difference in their genetic makeup. The results were supported by the findings of Halevy and Mayak (1981), Mahesh (1996), Sathisha (1997), Patil (2001) and Mukund *et al.* (2004).

Among pot sizes used, S_1 (25 cm diameter) registered maximum plant height (32.95 cm) and it was minimum (26.80 cm) in S_3 (15 cm diameter). The higher plant height in large size pots could be due to the reason that bigger size containers could have accommodated more amount of growing substrate that has been helpful in providing sufficient nutrients and space for growth of adequate root system. These results are in close conformity with the findings of Vernieri *et al.* (2003) in sunflower and Gupta (2013) in *Primula melacoides*. Among interactions, plant height was significantly higher in the treatment combination, $V_{15} * S_1$ (53.08 cm), *i.e.* when plants of cv. Royalty were grown in 25 cm diameter pots and found to be significantly higher over other interactions. However, minimum plant height (20.60 cm) was recorded in the interaction $V_{13} * S_3$ *i.e.* when plants of cv. Lady Love were grown in 15 cm diameter pots. The production of taller plants in the interaction, $V_{15} * S_1$ could be attributed to the reasons that cv. 'Royalty' have exhibited more genetic vigour in general and particularly when its plants were grown in the larger size pots in comparison to all other cultivars tested. Similar findings have been by Carvalho *et al.* (2008) in *Kalanchoe blossfeldiana*.

Number of shoots/plant

The pooled data in Table 1 indicated that cultivars as well as pot sizes have exhibited significant influence on number of shoots/plant. Maximum number of shoots (22.77) were reported in cv. White Bouquet and minimum (9.23) in cv. John Herrens. The inherent capacity of cultivars to produce either more or less shoots may be ascribed to the existence of genetic variability among the cultivars tested. These findings are in line with the work of Banko (1985) who reported varied responses of seven azalea cultivars with respect to production of shoots and laterals and ascribed the same to the difference in their genetic makeup.

Regarding the influence of pot sizes, plants grown in S_1 registered maximum number of shoots/plant (17.35) and minimum (13.88) was recorded in S_3 . More number of shoots produced in larger pots may be due to availability of more space and higher amount of growing substrate accommodated which might have ensured requisite physico-chemical and biological properties required for

Table 1 Effect of pot size and cultivars on plant height, number of shoots/plant, plant spread and days taken for flowering (pooled data) of potted azaleas

Cultivar	Plant height (cm)			Number of shoots/plant			Plant spread (cm)			Days taken for flowering						
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean				
John Herrens(V ₁)	25.65	23.84	22.61	24.03	11.31	8.72	7.65	9.23	21.46	19.16	16.85	19.16	258.2	254.6	251.6	254.7
Winter Hawk(V ₂)	24.60	22.39	22.58	23.19	22.12	17.99	15.08	18.40	29.52	28.10	25.50	27.71	269.4	264.2	262.2	265.3
White Rosebud(V ₃)	42.37	36.05	33.48	37.30	16.03	15.10	14.48	15.20	30.60	26.97	24.78	27.45	239.2	236.3	233.2	236.3
Boy-O-Boy(V ₄)	25.08	24.04	21.73	23.62	23.41	18.86	15.01	19.10	29.87	25.16	21.76	25.60	268.9	266.6	264.2	266.6
Summer Time(V ₅)	29.23	27.02	24.91	27.05	20.53	17.75	16.59	18.29	31.70	29.21	28.39	29.77	278.4	272.2	268.0	272.9
Pink Tama(V ₆)	25.38	23.28	21.14	23.27	18.19	16.82	16.73	17.25	35.07	30.64	28.87	31.53	276.5	274.4	270.0	273.6
Red Tomahawk(V ₇)	29.01	23.74	22.19	24.98	16.71	14.23	13.71	14.88	28.42	24.14	24.14	25.57	253.3	233.4	228.7	238.5
Shanghai Baby(V ₈)	30.65	24.78	20.67	25.37	20.13	17.17	14.68	17.33	30.11	28.24	25.46	27.94	222.6	219.0	215.3	218.9
Super Red(V ₉)	28.85	26.51	24.13	26.50	14.80	13.65	13.00	13.82	29.08	27.11	25.71	27.30	221.3	218.9	215.3	218.5
Nightingale(V ₁₀)	33.41	29.86	26.54	29.94	13.57	12.51	11.26	12.45	28.75	26.25	22.28	25.76	248.6	247.6	246.2	247.5
Empress(V ₁₁)	43.52	38.20	34.75	38.83	15.68	14.37	12.44	14.17	27.58	26.93	24.11	26.21	363.1	369.6	366.9	366.5
White Bouquet(V ₁₂)	32.62	26.91	30.97	30.17	25.51	23.16	19.63	22.77	74.71	30.97	29.85	45.18	223.8	222.2	218.8	221.6
Lady Love(V ₁₃)	26.68	24.94	20.60	24.07	14.45	13.03	11.22	12.90	24.05	24.00	20.03	22.69	208.7	207.0	203.8	206.5
Anniversary Joy(V ₁₄)	44.16	38.43	34.17	38.92	12.21	12.37	11.61	12.06	25.67	23.32	21.17	23.39	242.4	240.6	237.2	240.1
Royalty(V ₁₅)	53.08	46.27	41.51	46.95	15.63	14.54	15.10	15.09	34.35	32.11	28.65	31.70	166.6	147.4	144.5	152.9
Mean	32.95	29.09	26.80		17.35	15.35	13.88		32.06	26.82	24.51		249.4	244.9	241.7	
CD(P=0.05)																
Cultivars	=			0.63				0.56					9.23			6.19
Pot sizes	=			0.28				0.25					4.13			2.77
Cultivars × Pot sizes	=			1.08				0.99					16.01			10.74

S1, S2, S3 – Pots of diameter 24 cm, 20 cm and 15 cm respectively.

the growth of azalea plants. These results get the support of findings of Van Iersel (1997) in *Salvia splendens* and Gupta (2013) in *Primula melacoides*. Among interaction, higher number of shoots per plant (25.51) were recorded in the treatment combination, $V_{12} * S_1$ i.e. when plants of cv. White Bouquet were grown in 25 cm diameter pots whereas minimum (7.65) was recorded in $V_1 * S_3$ i.e. when plants of cv. John Herrens were grown in 15 cm diameter pots. The production of more number of shoots/plant in the interaction, $V_{12} * S_1$ could be ascribed to the reasons that cv. 'White Bouquet' have exhibited its capacity to develop more shoots/laterals per plant comparatively as a consequence of its better genetic makeup especially when grown in the larger size pots. Similar findings have been by Carvalho *et al.*, (2008) in *Kalanchoe blossfeldiana* and Goretta *et al.* (2008) in Poinsettia.

Plant spread (cm)

A perusal of pooled data in Table 1 revealed that cultivars as well as pot sizes exhibited significant effects on plant spread. Maximum plant spread (45.18 cm) was also observed in cv. White Bouquet and minimum (19.16 cm) in cv. John Herrens. It may be ascribed due to the reason that this cultivar has resulted in the production of more number of lateral shoots per plant as a consequence of its inherent capacity. So, leading to wider spread of plants. The genetic variability for various growth characteristics of azalea cultivars have been documented by Banko (1985) and Frank *et al.* (1987).

Among pot sizes used, plants grown in S_1 recorded maximum plant spread (32.06 cm) and it was minimum in S_3 (24.51 cm). More plant spread in 25 cm diameter pots could be due to more amount of growing substrate, that have assured optimum physico-chemical properties besides providing sufficient space for development of better root system. These findings are in close agreement with the earlier work of Vernieri *et al.* (2003) in sunflower. Among interactions, maximum plant spread (74.71 cm) was found in the treatment combination, $V_{12} * S_1$ i.e. when plants of cv. White Bouquet were grown in 25 cm diameter pots and found to be significantly higher over other interactions and it was minimum (16.85 cm) in the interaction, $V_1 * S_3$ i.e. when plants of cv. John Herrens were grown in 15 cm diameter pots. The production of wider plants in the interaction, $V_{12} * S_1$ could be attributed to the reasons that cv. White Bouquet have produced more laterals as a consequence of its inherent capacity particularly when its plants were grown in the larger size pots in comparison to all other cultivars tested. Similar results have been reported in *Hydrangea macrophylla* by Artetxe *et al.* (1997).

Number of days taken for flowering

It is evident from pooled data arranged in Table 1 that cultivars as well as pot sizes exhibited significant effects on days taken for flowering. Minimum time taken for flowering (152.9 days) was observed in cv. Royalty and maximum (366.5 days) in cv. Empress. The variation in time taken

for flowering among the various cultivars tested could be attributed to the difference in their genetic makeup. The flowering behaviour of various azalea cultivars has been placed on record by Criley (1985) and concluded that the variation in flowering behaviour of different azalea cultivars could be ascribed to their genetic makeup. Our findings also got support from the earlier work of Kohl and Sciaroni (1956), Heursel (1976) and Kobayashi *et al.* (2010).

Among pot sizes used, S_3 took less number of days for flowering (241.7 days) and maximum number of days taken for flowering (249.4 days) was recorded in S_1 . This might be due to the reason that plants grown in smaller pots failed to put up vigorous vegetative growth and as a result there was early induction of reproductive buds which later on turns into flowering. Schenk and Brundert (1979) have also opined that in small size pots growth was less vigorous, hence occurrence of early flowering. Among interactions, minimum time taken for flowering was recorded in the treatment combination, $V_{15} * S_3$ (144.5 days), i.e. when plants of cv. Royalty were grown in 15 cm diameter pots and maximum (369.6 days) was recorded in $V_{11} * S_2$, i.e. when plants of cv. Empress were grown in 20 cm diameter pots. The quantitative difference in the time taken for induction of reproductive buds and flowering as well can be ascribed to the differential flowering behaviour of the cultivars due to the obvious variability in their genotypic makeup which has got further widening as a consequence of capacity of the pots of varying sizes. These results get the support from the earlier findings of Carvalho *et al.*, (2008) in *Kalanchoe blossfeldiana* and Vernieri *et al.*, (2003) in sunflower.

Number of (flowers/plant)

A perusal of pooled data in Table 2 indicated the significant effect of cultivars as well as pot sizes on production of flowers/plant. Maximum number of flowers/plant (27.39) were produced in cv. white Bouquet and minimum (19.16 cm) in cv. Pink Tama. The difference in the production of flowers per plant among various azalea cultivars under study could be attributed to their inherent capacity to develop vegetative shoots and laterals which later on developed sufficient number of vegetative buds that got converted into flowering buds hence more number of flowers per plant. These results are in agreement to the earlier reports of Kunishige *et al.* (1984) and Marosz and Matysiak (2005).

Among pot sizes, S_1 pots resulted in production of maximum number of flowers per plant (18.04) and it was minimum (13.64) in S_3 pots. This may be due to reason that large size containers produced maximum number of flowering shoots per plant and so more flowers per plant. Similar results have also been reported earlier by Gupta (2013) and Keever *et al.*, (1985). Among interactions, number of flowers/plant was found to be highest in the treatment combination, $V_{12} * S_1$ (34.50), i.e. when plants of cv. 'White Bouquet' were grown in 25 cm diameter pots and were significantly higher over other interactions. Whereas, minimum was recorded in treatment combination

Table 2 Effect of pot size and cultivars on number of flowers per plant, flower diameter (cm), maximum number of flowers opened at a time and pot presentability of potted azaleas

Cultivar	Number of flowers/plant				Flower diameter (cm)				Maximum number of flowers opened at a time				Pot presentability			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
John Herrens(V ₁)	15.83	14.10	13.57	14.50	6.65	6.47	5.74	6.28	12.17	10.97	10.30	11.15	71.83	64.99	59.83	65.55
Winter Hawk(V ₂)	15.10	12.63	11.90	13.21	5.83	5.25	5.15	5.41	8.63	7.57	7.03	7.74	67.83	60.17	62.33	63.44
White Rosebud(V ₃)	13.50	12.83	12.83	13.05	4.85	4.83	4.68	4.79	10.57	9.37	8.30	9.41	63.33	59.50	57.83	60.22
Boy-O-Boy(V ₄)	29.70	27.03	19.50	25.41	5.82	5.73	5.67	5.74	20.83	19.77	15.37	18.66	90.17	83.83	76.17	83.39
Summer Time(V ₅)	9.77	8.63	7.25	8.55	8.73	8.63	8.43	8.59	7.37	6.23	6.27	6.62	62.17	54.83	50.83	55.94
Pink Tama(V ₆)	8.77	7.77	6.83	7.79	11.08	10.98	10.75	10.94	6.97	6.17	5.57	6.24	61.17	52.83	51.17	55.06
Red Tomahawk(V ₇)	23.68	18.57	17.57	19.94	7.35	7.18	6.98	7.17	18.31	14.90	13.63	15.61	84.83	79.67	70.83	77.04
Shanghai Baby(V ₈)	23.50	21.50	18.27	21.09	6.95	6.80	6.65	6.80	19.70	18.17	16.17	18.01	88.17	82.00	74.17	81.45
Super Red(V ₉)	19.10	16.13	13.73	16.32	7.05	7.01	6.68	6.91	13.97	11.77	9.90	11.88	83.17	77.17	68.17	66.17
Nightingale(V ₁₀)	14.97	13.08	12.08	13.38	7.35	7.33	7.03	7.24	16.11	14.56	13.85	14.84	63.83	55.83	52.33	57.33
Empress(V ₁₁)	16.63	14.27	12.42	14.44	5.99	5.92	5.65	5.85	10.77	11.23	10.33	10.78	71.17	63.17	59.17	64.50
White Bouquet(V ₁₂)	34.50	26.57	21.10	27.39	7.97	7.82	7.62	7.80	22.90	18.10	17.03	19.34	91.16	85.17	76.67	84.33
Lady Love(V ₁₃)	16.50	14.93	13.45	14.96	7.67	7.53	7.36	7.52	13.07	11.57	10.50	11.71	79.83	74.83	66.17	73.61
Anniversary Joy(V ₁₄)	14.47	11.97	12.07	12.65	8.35	7.78	7.29	7.81	9.77	9.10	8.10	8.99	65.83	56.83	54.17	58.94
Royalty(V ₁₅)	14.57	13.30	13.06	13.50	8.05	7.77	7.45	7.76	11.33	10.07	9.07	10.16	76.17	71.33	62.67	70.06
Mean	18.04	15.55	13.64	16.44	7.31	7.13	6.88	7.13	13.50	11.97	10.76	12.15	74.71	68.14	62.83	70.06
CD (P=0.05)																
Cultivars	=		0.55				0.58					0.66				0.55
Pot sizes	=		0.24				0.26					0.29				0.24
Cultivars × Pot sizes	=		0.95				1.01					1.15				0.95

S₁, S₂, S₃– Pots of diameter 25 cm, 20 cm and 15 cm respectively.

(16.85 cm), $V_6 * S_3$, i.e. when plants of cv. Pink Tamma were grown in 15 cm diameter pots. The production of more number of flowers per plant in the interaction, $V_{12} * S_1$ could be attributed to the reasons that cv. White Bouquet have produced more number of shoots and laterals which later on become reproductive as a consequence of its inherent capacity particularly when its plants were grown in the larger size pots in comparison to all other cultivars tested. Similar findings have also been documented by Carvalho *et al.* (2008).

Flower diameter (cm)

The pooled data in Table 2 indicated the significant effect of cultivars and pot sizes on flower diameter. The largest size flowers (10.94 cm) were produced in cv. Pink Tama and smallest (4.79 cm) were produced in cv. White Rosebud. The variation in flower diameter of various cultivars tested may be due to the effect of difference in their genetic makeup. The results got the support from the findings of Heursel (1976) and Kunishige *et al.* (1984) in various azalea cultivars.

Among pot sizes, plants grown in S_1 pot size resulted in maximum flower size (7.31 cm) and smallest flowers were produced in S_3 (6.88 cm). The difference in the diameter of flowers produced could be attributed to the capacity of pots to accommodate potting mixture and assuring of space for root growth and development besides providing the nutrients to the growing plants. These results got the support of earlier work of Vernieri *et al.* (2003) and Keever *et al.* (1985). Among interactions, flower size was significantly higher in the treatment combination, $V_6 * S_1$ (11.08 cm), i.e. when plants of cv. White Bouquet were grown in 25 cm diameter pots. Whereas, minimum flower size (4.68 cm) was recorded in treatment combination, $V_3 * S_3$, i.e. when plants of cv. White Rosebud were grown in 15 cm diameter pots. The production of large size flowers in the interaction, $V_6 * S_1$ could be ascribed to the effect of superiority of the genotype of cv. Pink Tamma which was further influenced by growing in larger size containers. Similar results have been reported by Biermann (1982) in cyclamen and Artetxe *et al.*, (1997) in *Hydrangea macrophylla*.

Maximum number of flowers opened at a time

A perusal of data in Table 2 indicated the significant effect of cultivars and pot sizes on maximum number of flowers opened at a time. Maximum number of flowers opened at a time (19.34) were reported in cv. White Bouquet and minimum (6.24) was in cv. Pink Tamma. It could be attributed to the superiority of the genetic makeup of cv. White Bouquet. The genetic variability among azalea cultivars have been documented by various workers for different growth and flowering attributes (Heursel 1976, Kunishige *et al.* 1984).

Among pot sizes, plants grown in S_1 registered maximum number of flowers opened at a time (13.50) and minimum was recorded in S_3 pots. The difference in the number of flowers remaining open at a time could be due

to the reason that more number of flowers were produced in larger pots as compared to smaller pots, hence resulted in more number of flowers remaining opened at a time. These results got the support of earlier work of Vernieri *et al.* (2003) and Gupta (2013). Among interactions, number of flowers opened at a time was significantly higher in the treatment combination, $V_{12} * S_1$ (22.90), i.e. when plants of cv. White Bouquet were grown in 25 cm diameter pots. Whereas, minimum number of flowers opened at a time (5.57) was recorded in interaction, $V_6 * S_3$, i.e. when plants of cv. Pink Tamma were grown in 15 cm diameter pots. The more number of flowers remaining opened at a time in the interaction, $V_6 * S_1$ could be ascribed to the effect of superiority of the genotype of cv. Pink Tamma which was further influenced by growing in larger size containers. Similar results have been reported by Carvalho *et al.* (2008).

Pot presentability

The pooled data in Table 2 indicated the significant effect of cultivars as well as pot sizes on pot presentability score. Maximum pot presentability score (84.33) was observed in cv. White Bouquet and minimum (55.06) was in cv. Pink Tama. It could be attributed to the reason that the said cultivar attained plant height quite matchable to the container size, produced sufficient number of shoots, attained wider plant spread, developed more number of flowers/plant as well as maximum number of flowers that remained fresh and opened at a time, besides exhibiting prolonged flowering duration as a consequence of its inherent genetic superiority in comparison to all other cultivars tested.

Regarding the effect of pot sizes, plants grown in S_1 registered maximum pot presentability score (74.71) and it was minimum (62.83) in S_3 pots. It could be ascribed to the reason that this pot size has resulted in the production of plants with the most desirable growth and flowering parameters on the basis of which the score of presentability was worked out. These results are in consonance with the findings of Gupta (2013). Among interactions, significantly higher pot presentability score (91.16) was recorded in the interaction, $V_{12} * S_1$, i.e. when plants of cv. White Bouquet were grown in 25 cm diameter pots. Whereas, minimum (50.83) was recorded in $V_5 * S_3$, i.e. when plants of cv. Summer Time were grown in 15 cm diameter pots. This may be due to the fact that the combined effect of superior genotype of plants and large pot sizes resulted in the production of potted azaleas with comparatively higher values for various desirable growth and flowering characters thus attaining better pot presentability score. Similar results have been documented by Gupta (2013) in *Primula melacoides*.

REFERENCES

- Artetxe A, Teres V and Beunza AI. 1997. Effect of container size and substrate on *Hydrangea macrophylla* growth. *Acta Horticulturae* **450**: 419–24.
- Banko T J. 1985. Evaluation of growth regulator effects of Embark, Atrinal, Blazers and Bayleton on container grown azaleas. *Journal of Environmental Horticulture* **3**(4): 149–52.

- Biermann W. 1982. Variety tests with various sowing dates and using of various pot sizes. *Gb + Gw* **82**(46): 1097–101.
- Cantliffe DJ. 1993. Pre and postharvest practices for improved vegetable transplant quality. *Horticulture Technology* **3**: 415–7.
- Carvalho S M P, Almeida J, Eveleens C B, Bakker M J and Heuvelink E. 2008. Modelling visual quality of *Kalanchoe blossfeldiana*: influence of cultivar and pot size. *Acta Horticulturae* **801**: 1069–76.
- Conover C A. 1986. Quality. *Acta Horticultur* **181**: 201–5.
- Criley R A. 1985. Rhododendrons and azaleas. (In): CRC *Handbook of Flowering* Halevy A H (Ed), pp 180–97. CRC Press, Boca Raton, USA.
- Frank J R, Krause R C and Beste C E. 1987. Effect of three herbicides on the foliage of Kurume azaleas. *Journal of Environmental Horticulture* **5**(2): 55–62.
- Gomez L A and Gomez A A. 1984. *Statistical Procedures for Agricultural Research*, 3rd ed, p 680. John Wiley and Sons, Singapore.
- Goreta S, Batelja K and Perica S. 2008. Growth of poinsettia as affected by cultivar, thinning and pot size. *Horticulture technology 41* **18**(1): 122–9.
- Gupta J. 2013. 'Effect of growing substrates and pot size on growth and flowering of *Primula malacoides* Franch'. MSc thesis, UHF. Nauni, Solan.
- Halevy A H and Mayak S. 1981. Senescence and post harvest physiology of cut flowers. *Horticultural Reviews Part II*. **3**: 59–143.
- Heursel J. 1976. Comparison of the new azalea cv. Osaka with older cultivars. *Mededelingen van het Rijksstation en de Werkgroep voor de Sierplantenteelt* **35**: 9–21.
- Keever G J, Cobb G S and Reed R B. 1985. Effect of container dimension and volume on growth of three woody ornamentals. *Hort Science* **20**: 276–78.
- Kobayashi N, Ishihara M, Ohtani M, Cheon K S, Mizuta D, Tasaki K and Natatsuka A. 2010. Evaluation and applications of the long lasting flower trait of azalea cultivars. *Acta Horticulturae* **855**: 165–8.
- Kohl H C and Sciaroni R H. 1956. Bud initiation of azaleas. *California Agriculture*. p 15.
- Kunishige M, Tamura T, Morishita M and Yamaguchi S. 1984. Breeding of the new azalea cultivar Benifusha. Bulletin, Vegetable and Ornamental Crops Research Station, C Kurume. **7**: 55–65.
- Leiser AT. 1975. Taxonomy and origin of azaleas used for forcing. (In): Kofranek A M and Larson R A. (Eds). *Growing Azaleas Commercially*, pp 9–14. University of California, Berkeley.
- hesh K. 1996. 'Variability studies in carnation (*Dianthus caryophyllus* L.)'. MSc thesis, University of Agricultural Sciences, Bangalore.
- Marosz A and Matysiak B. 2005. Influence of growth retardants on growth and flower bud formation in rhododendron and azalea. *Dendrobiology* **54**: 34–40.
- McConnell D B. 1987. Container size and potting medium affect growth rate of weeping fig and loquat. *Proc. Florida State Horticulture Society* **100**: 337–9.
- Mukund S, Shirol A M, Kiran K G and Reddy B S and Kulkarni B S. 2004. Evaluation of standard carnation cultivars for their flowering, flower quality and yield parameters under protected cultivation. *Journal of Ornamental Horticulture* **7**(3-4): 206–7.
- Patil R T. 2001. 'Evaluation of standard carnation (*Dianthus caryophyllus*) under protected conditions'. MSc thesis, University of Agricultural Sciences, Dharwad.
- Reiley H E. 2004. *Success in Rhododendron and Azaleas*, p 284. Timber Press, Portland, Cambridge.
- Sathisha S. 1997. 'Evaluation of carnation (*Dianthus caryophyllus*) cultivars under low cost greenhouse'. MSc thesis, University of Agricultural Sciences, Bangalore.
- Scariot V Gullino P. 2010. Evaluation of flowering time and ornamental characteristics in autumn camellias. *Acta Horticulturae* **855**: 319–24.
- Schenk M. and Brundert W. 1979. Effect of pot material and size on growth in hydroculture. *Deutscher-Gartebau* **33**(21): 898.
- Van Iersel M. 1997. Root restriction effects on growth and development of *Salvia splendens*. *Hort Science* **32**: 1186–90.
- Vernieri P, Incrocci G, Tognoni F and Serra G. 2003. Effect of cultivars, timing, growth retardants and potting type on potted sunflowers production. *Acta Horticulturae* **614**(1): 313–8.